

# **Total Time Required: 2-3 45-90 minute periods**

# **Grade Level:** 5

**Ship the Chip**

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# **Lesson Objectives: (List any 3 that directly apply to the lesson)**

Students will be able to:

* Differentiate between mass, volume, surface area and weight.
* Prepare a package to ship a chip using the engineering design process.
* Measure and find mass, volume, surface area and weight.

# **Indiana Science Standards: (Identify 2 content/subject-specific standards and 3 design process-specific standards)**

***Content specific***

* 5.1.1 Describe and measure the volume and weight of a sample of a given material.
* 5.1.2 Describe the difference between weight and mass. Understand that weight is dependent on gravity and mass is the amount of matter in a given substance or material.

***The Design Process***

* Select the most appropriate materials to develop a solution that will meet the need.
* Test and evaluate how well the solution meets the goal.
* Evaluate and test the design using measurement.

# **Mathematics Connections: (Identify 2 or 3 connections or standards that apply)**

Standards:

* 5.MD.3 Recognize volume as an attribute of solid figures and understand concepts of volume measurement.
* 5.MD.5 Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.

# **Science Concepts / Vocabulary:**

While the purpose of this activity is to engage students in the engineering design process, they will also be working on learning important science content and vocabulary such as, what is volume, mass, weight and surface area? This being said, we will cover how to calculate and find each of the important measures. To find volume, we will demonstrate how to find the volume of a box by using the volume formula (length x width x height). Next, we want the students to know the difference between mass and weight. We will have a discussion about mass being a set amount of material within an object while weight is dependent on gravity and the force of gravity. For example, our weight on Earth is a lot different than on the moon because gravity on the Earth is a lot more. We would weigh more on the moon because gravity is less. We will also cover surface area. The students will learn that to find surface area, they need to know the height, width, and depth. These are the factors that affect surface area. Using all these mathematical/science terms, we will make sure students understand how to use and define each one in relation to creating a package for their chip. It is also important to note that volume and surface area can be hard to differentiate. The students will learn that surface area is the area of a flat surface and measured in square units. Volume is the area taken up inside an object and measured in cubic units.

|  |  |  |
| --- | --- | --- |
| ***Term*** | ***Defined by a scientist or engineer*** | ***Defined by a 5th or 6th grade student*** |
| Volume | The amount of three-dimensional space an object occupies. | The amount of space taken up by an object. |
| Mass | The measure of how much mass is in an object. | The amount of stuff in an object. |
| Weight | The downward force caused by gravity on an object. | How much something weighs. |
| Surface Area | The total area of the surface of a three dimensional objects. | The total area that can be measured on the entire surface. |
| Height | The vertical distance from top to bottom | Distance from the base of something to the top. |
| Width | The distance from side to side. | The extent of something from side to side. |
| Depth | Distance from the top or surface of something to its bottom. | The extent downward, backward or inward. |

**Concepts and Vocabulary**

**Equipment, Materials and Tools**

**List the quantities of all materials and equipment needed:**

|  |  |  |  |
| --- | --- | --- | --- |
| *Tools* | *Materials* |  |  |
| Rulers | Pringles | Cotton balls |  |
| Pencils | Newspaper | Toothpicks |  |
| Scale or balance | Glue | Wax paper |  |
|  | tape | Paper towels |  |

**Special Materials Notes and Comments**

Include specific scientific information relevant to the task (i.e., comprehensive explanations of the “science concepts” and how they are related). Include graphics, illustrations, or concept maps. List relevant web sites. Note any special materials or procedures that need to be included or followed.

Each science term that is being taught and described in this lesson is previously linked to one another and each term helps to better understand the next.  In most everyday uses of the word mass, it is often related to weight. It is important for students to understand that weight and mass are different. For example: The mass is the same of on any object, but the weight of the object has to do with the location and how gravity is affecting the object. For example: mass does not change with the position of an object, movement, or the shape, unless material is added or there is material that is removed and weight is the gravitational force acting on a body mass.  Volume is the amount of space that an object takes up, whereas surface area is the total area of an object. An example for volume would be a bowling ball and a basketball, because they have a similar shape and size they have a similar volume and an example of surface area would be a rectangular garden and in order to get the surface area of the garden you would take the length of the garden times the width. All of these terms will play a role in the packages that the students come up with. Students will use surface area to determine the depth, width, and height of their package. They will work with volume to find the most efficient size that their package will be, as well as the mass and weight to determine whether their package should be heavy or light. As you can see, all of these terms will be used to determine the outcome of the student’s package and they will also help the students assess the effectiveness of the package.

Packaging Engineers

Students are acting much like a packaging engineer. Packaging engineers interact with the research and development, manufacturing, marketing, graphic design, purchasing, planning and many other areas. They want their package to sell the product, while maintain an efficient, cost effective process cycle. Engineers must also use a wide variety of materials, much like the students will be doing when designing a product to fit a specific need. In our lesson, the students are working to protect a chip.

<http://en.wikipedia.org/wiki/Packaging_engineering>

**Lesson Plan #1**

**Guiding Question – What are the functions of packages and what materials are used?**

**Time:** 45 minutes

**Procedures / Steps:**

1. The students are presented with a cereal box. We will ask them to “examine the cereal box and pay special attention to its characteristics.”
2. Discuss with students what packages function as. Ask: “What are the functions of packages?”
3. Next ask: “Brainstorm what you think packages are made of or what materials are used for packaging.” Create a list on the board for the students to see. “Do you think there are better materials that can be used versus others?”
4. Next introduce the concepts of volume, weight, mass and surface area. For each term, discuss the definitions and how they are used:
   1. “Volume is used to find the amount of space a 3-demensional object takes up. We find this with our packages by taking length times width times height.”
   2. “Mass and weight are roughly the same thing but are different in their relation to gravity. Mass is always constant, being the amount of mass in an object has and weight is relative to its gravitational pull.”
   3. Surface area will be used to measure the total space of the surface of a three dimensional object. (measured in square units)
   4. State that we will use all customary units of measure for all units of measurement.
5. Explain that they will be in charge of creating a package to ship to Wea Ridge Middle School. Present the design challenge brief.
6. Discuss with the students who the client is, who the user is and what the brief is telling them. “You are being hired by Sunny Snacks to ship a chip to Wea Ridge, the user. Recall what we have discussed about packaging and what materials are beneficial or might be effective when it comes to packaging.”
7. Briefly state that in the next couple of sessions, they will be working in design teams to complete this challenge.
   1. On the board, write down: What is the problem, Who is the client, Who is the end user, and what is the goal?
   2. Have the students discuss the answers to these questions and write them in their design notebooks.

**Lesson Plan #2**

**Guiding Question – Can you design a prototype that mimics the qualities of an effective package?**

**Time: 60 minutes**

**Procedures / Steps:**

1. Instruct students that they are going to design a prototype that will safely and securely transport a chip to Wea Ridge, with the goal of the chip arriving in mint condition. Review with students the design brief by encouraging students to remind you what the goal is, who the client is, what the clients’ needs are, and who the end user is.
2. At the front of the room, have on display or show the students the materials they will be able to work with to create their packages. Tell them that they are only allowed to use the materials present.
3. In their design notebooks, tell them to create an individual design sketch, clearly illustrating their idea for their package. Tell them to include labels, dimensions (volume, surface area, weight, mass), and different angles of the package. (Allow 15 minutes for them to do this using the online stopwatch). If students want to weigh particular materials, tell them they may do so at this time.
4. Instruct them to think about the key terms and how they might affect how well their chip ships. Should their package be large, small, light, heavy, etc.?
5. Once they have created their individual designs, they will be placed in teams to create a team design. Tell the students they are to share their own designs with each other to come up with a team design, illustrating a detailed plan with the labels and dimensions and angles. (allow 15 minutes for this stage using an online stopwatch).
6. Once a team design is created, they are to plan with their groups how they will test the quality of their package. “Will you throw it, shake it, bounce it etc.?” They are to write down how they will test it in their notebooks. Their tests should include repeated trials, which will be recorded and reported in their design notebooks. (5 minutes)
7. If all the planning is complete, the design teams may begin the construction phase of the design challenge if time allows.

**Lesson Plan #3**

**Design Challenge – Can you build a prototype that mimics an effective package?**

**Time: 60-90 minutes**

**Procedures / Steps:**

**Preparation:**

1. If teams have not already begun the construction of their packages, they may do so now. Each team will be provided with one chip to use and help with the construction process.
2. Teams will have 25 minutes to construct their package. The time will be monitored on the online stopwatch application and displayed on the Smartboard.
3. During construction, ask the students questions such as, “How much does your package weigh? What key terms can you use to describe what you are doing? Why are you using the materials you are?”
4. After construction is complete, each team will record their weight/mass, volume and surface area of their package without the chip in their package. They will also weigh the package with the chip in the package. “How might what you know about packaging inform your design for your chip package?”
5. Next, each team will test their package with the chip sealed into the package. They will do this by completing the tests they planned earlier in their design notebooks by shaking, dropping or bouncing it. Repeated trials should be done and reported in their design notebooks to show the results of these tests. (allow 10 minutes for this)
6. After they test their package, they can open it up and see the results of their chip.
7. At this point, if they are satisfied with their package, they may change minor changes or keep it the same. If teams chips broke or something needs to be changed, the teams may redesign their package. (allow 15 minutes for this). A guiding question for them to think about at this stage could be: “What kinds of scientific concepts could explain your results?”
8. After redesign, the teams must prepare their packages for shipping. They should put their team name or names on the outside of the package or insert a slip into the package with their names on it so it is easily identified after being shipped. They must make sure a chip is in the package and that it is properly secured for shipment. (allow 10 minutes for this).

**Lesson Plan #4**

**Design Challenge – *What feedback do you get on your design?***

**Time: 45 minutes**

**Procedures / Steps:**

1. At the end of the lesson, students will take the data that they recorded about their package and put it on the board (includes, weight, volume, surface areas). Each group will do this individually.
2. After the information has been recorded on the board, the teacher should facilitate a discussion comparing the data tables and their results as well as what they learned through the design process when they were building their packages. Discussion questions include: “What similarities do you notice about the data on the board and the performance of the packages? Why are all the values not all the same? What were the results of your shake tests? What do you predict will be the final result for your chip and why do you think that?”
3. The teacher could ask them what they thought worked best or what they would have changed on their package if they had more time or could start over.
4. Lastly to wrap up the lesson, have students write a paragraph in their design notebooks, This paragraph also accesses student’s individual content knowledge:

Students should answer the following questions in their design notebook: Why do you think your package was successful/not successful and discuss the key terms you have learned such as weight, mass, volume, and surface area, and which of these led to the best outcome for your package by answering the following questions: “How do you think the weight of your package will affect the outcome? Do you think that the surface area of your package will make a difference? What is the difference between weight and mass? How did you determine the volume of your package?

1. Give the students a copy of the rubric that the Wea students will be using to assess their chips and packages. Tell the students that the packages will be assessed based on whether or not the chip made it successfully without being cracked or broken. The packages will also be assessed based on what the students wrote down in their design notebook and the results that they concluded using the key terms that they learned. Wea Ridge students will also be a part of the assessment of the package because they will be receiving the chip and determine if it is broken or not. The students at Sunnyside will know the results of there package once the Wea Students respond.
   1. Using the Smartboard, show students a picture of a Pringle chip. Ask them how they would score the chip. Show pictures of chips in a random order.

**Assessment**

The following are possible sources of formative and summative assessment:

The following rubric assess students’ content knowledge. It is based off of a small write up in their design notebooks answering: Why do you think your package was successful/not successful? Discuss the key terms you have learned such as weight, mass, volume, and surface area and which of these aspects leads to the best package.

|  |  |  |  |
| --- | --- | --- | --- |
|  | 0 | 1 | 2 |
| Use of key terms | No key terms are used | Some terms (1-2) are used | Most or all terms are used (3-4) |
| Explanation of success of package | No explanation present | Explanation is unclear | Explanation is clear and gives reasons for success/unsuccessfulness |
| What aspects lead to a successful package design? | No suggestions are made | Suggestions are made but are unclear with no support for the suggestions. | Suggestions are made and support is given for the suggestions. |
| Key terms used correctly | Key terms are used incorrectly | Key terms are used but are unclear | Key terms are used accurately |

The following rubric will be used to assess students’ ability to engage in design. It will be used to assess their diagrams/pictures in their design notebooks.

|  |  |  |  |
| --- | --- | --- | --- |
|  | 0 | 1 | 2 |
| Design present in notebook | No design is present in notebook | Design is present but unclear | Design is present and legible |
| Labels on design drawing (materials used) | No labels are present | Not all components are labeled, explaining what materials are used where. | Labels are used explaining the materials used and where they are used |
| Dimensions are used (measurements) | No dimensions are shown | Some dimensions are used but are unclear or not to scale | Dimensions are used, clear, and to scale |
| Views of drawings | No viewpoints are present | Only one viewpoint is shown | Multiple viewpoints/side views are shown |

The following rubric will be given to the receiving school to score the packages of the Sunny Side class:

***PRINGLES SCORING GUIDE***

|  |  |  |
| --- | --- | --- |
| http://www.gatesscience.info/teamescience/images/tater.gif | PERFECTLY INTACT- (The chip survives! Like it just left the factory) | 100 Points |
| http://www.gatesscience.info/teamescience/images/tater/tatercr.gif | SLIGHTLY DAMAGED - (cracked, but still in one piece) | 50 Points |
| http://www.gatesscience.info/teamescience/images/tater/taterch.gif | A CHIPPED CHIP - (chipped along the edges or in multiple areas. Less than 5 pieces) | 10 Points |
| http://www.gatesscience.info/teamescience/images/tater/tatertwo.gif | A SPLIT CHIP  -  (chip is broken into 2 fairly equal pieces) | 10 Points |
| http://www.gatesscience.info/teamescience/images/tater/tatermore.gif | SIGNIFICANTLY DAMAGED - (chipped and/or cracked, less than 20 pieces) | 5 Points |
| http://www.gatesscience.info/teamescience/images/tater/taterdust.gif | POTATO DUST - (too many to count, more than 20 pieces) | 1 Point |

Pringles Scoring Continued:

The following measurement will be made by Wea Students:

1. Mass of the package in grams.
2. Volume of the package in cubic centimeters
3. Intactness score of the chip must be determined from the previous Pringle scale and awarded by Wea Students.
4. OVERALL SCORE: The overall score for a package will be the one used to determine the winners. This score will be calculated using the following equation:

Intactness score (c)

OVERALL SCORE = [mass in g (a) x volume in cubic centimeter (b)]

Example:

1. mass = 0.145 g
2. Volume = 240 cubic centimeters
3. Intactness score = 100 (perfect chip)
4. OVERALL SCORE = 100/[0.145g x 240 cc]

OVERALL SCORE = 2.87

**Lesson Extensions and Resources**

**Activity Extensions:** Students could be required to ship an item other than a chip, such as a plant or glass ornament. Students could also be given a particular kind of box. It would be the same size for each one of the groups and the challenge would be to design the best interior for the box so that the chip would not crack. Like said previously this could also be done with a plant.

Another extension for students would require a certain amount of materials. Students would only be given a certain amount of material that they had to work with instead of an unlimited amount. This would make the lesson more challenging and the students would have to work to develop the best design.

**Web Resources:**

<http://www.youtube.com/watch?v=nz859kgEBIA>= Youtube video explaining what Ship the chip is.

<http://www.tryengineering.org/lesson_detail.php?lesson=38>= Ship the Chip lesson plan from TryEngineering.

**Other Resources:**

“Pringles Design Challenge”



**Design Activity**

**Student Resource- Ship the Chip**

Sunny Snacks, a company in Lafayette, Indiana, needs assistance in designing a package to deliver their golden chips to Wea Ridge Elementary School. They need your help in designing a package that will better ship their golden chips safely without breaking, crushing or smashing. Your job is to present a new package that will safely ship a golden chip to a class at Wea Ridge, arriving in perfect condition as originally packaged.

The design, construction method, and materials used will determine the quality of the package in safely shipping the chip. You will want to test the quality of your package by dropping the package to see if the chip is still intact and redesign as needed. Measurements will need to be taken to calculate the weight, mass, volume and surface area of your package. You will first design your own plan for a package. Next, you will come up with a team design and begin construction.

Materials Available:

* Pringles
* Newspaper
* Glue
* Tape
* Cotton balls
* Toothpicks
* Wax paper
* Paper towels
* Rulers
* Pencils

Guidelines:

* Only use the provided materials
* Package must hold only 1 Pringle’s chip
* Can be no bigger than 6 in x 6 in x 6 in
* The package must be clearly labeled on the outside with the team or group number posted
* The team may write “Fragile” or “Handle with care” on the package